

Synthesis and Characterization of Polymer Organic Photovoltaic Cells incorporating Laser Ablation produced Silver Nanoparticles

The present diploma thesis demonstrates several effects that arise from the incorporation of metallic plasmonic Silver nanoparticles into the photoactive layer or between the hole transport layer and the photoactive layer of polymer-fullerene bulk heterojunction solar cells on their efficiency and electric characteristics. Nanoparticles with an approximate size of 100 nm were produced by Laser Ablation of a Silver target immersed in Chloroform with or without Polyvinylpyrrolidone and give rise to Localized Surface Plasmon Resonance effects (LSPR). Multilayered hybrid thin film organic solar cells with Silver nanoparticles were developed by liquid techniques comprised by the polymer P3HT as an electron donor and the small molecule organic compound PC60BM as an electron acceptor in the light absorption layer resulting in enhanced Power Conversion Efficiency in the order of 10% average and enhanced short circuit current density of 6% average as compared to the control solar cells in the case that Silver nanoparticles are placed into the photoactive layer. On the contrary, in the case that nanoparticles are placed between the hole transport layer and the photoactive layer a decrease of efficiency was observed. The surface morphology alteration of the photoactive layer due to Silver nanoparticles incorporation was investigated by means of Atomic Force Microscopy (AFM), whereas the elemental composition was uncovered by Scanning Electron Microscopy Microanalysis (EDS SEM). Furthermore, the structure of the photoactive layer was studied by X-Rays Diffractometry (XRD) and its optical properties by Spectroscopic Ellipsometry (SE). In conclude, the enhanced performance is found to originate mainly from improvement of the polymer-fullerene blend morphology due to the presence of Ag NPs, while Localized Surface Plasmon Resonance effects are found to have negligible effect on active layer absorption.